Rj. # 103

631
Beaverhead

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

REPORT OF THE SURVEYS
OF THE MOUNTAIN PINE BEETLE INFESTATION ON THE BEAVERHEAD NATIONAL FOREST
-1933-

by
A. L. Gibson
Assistant Entomologist

Forest Insect Laboratory
Coeur d'Alene, Idaho
July 25, 1934

U. S. GOVERNMENT PRINTING OFFICE: 1933   1-76133

REPORT OF THE SURVEYS
OF THE MOUNTAIN PINE BEETLE INFESTATION
ON THE BEAVERHEAD NATIONAL FOREST
-1933-

Respectfully submitted,

Archie L. Gibson
Assistant Entomologist

Forest Insect Laboratory
Coeur d'Alene, Idaho
July 25, 1934

REPORT OF THE SURVEYS
OF THE MOUNTAIN PINE BEETLE INFESTATION
ON THE BEAVERHEAD NATIONAL FOREST

-1933-

Introduction

During the five years in which these annual surveys have been conducted as a research project, a great deal has been learned concerning the behavior of a mountain pine beetle epidemic and the insect responsible for it, but each year seems only to indicate more phases of the problem to be studied before a clearer understanding may be gained of the factors affecting epidemics. When the survey was first undertaken as a research project, the number of attacked trees was the only data secured, but with each succeeding year the scope of the problem has been enlarged. The phases studied have been annual losses, duration of the period of attack, rates of increase, spread of infestation, sources of infestation, and the flights or dissemination of forest insects; losses which result directly from an epidemic, and indirect losses caused by secondary insects. It is planned to continue all the studies for the length of the project.

Prior to 1929 the surveys of the Beaverhead infestation were merely for the purpose of determining the number and location of the infested trees in order that control measures might be planned most efficiently. Control was begun in 1925 and continued until 1928. During the summer of 1928 the tremendous influx of beetles into the Beaverhead resulted in the attack of so many trees as to make further control work uneconomical, and the project was discontinued. The data from these early surveys, even though secured for control work and in spite of the undoubted influence of control work on the number of attacks for succeeding years, has been used for comparative purposes not because it is fully representative of actual conditions but because it is the only data available.

PRESENT STATUS OF THE BEAVERHEAD INFESTATION

The survey data included in this report for 1933 are for the area within the old boundary of the Beaverhead National Forest and the small area of public domain in the Sheep Canyon Hills about ten miles south of Dillon, Montana. Examination of certain portions of the forest have become a part of the project only within the last few years.

For the first time since this study was instituted an analysis of the 1933 data shows a decrease in the total amount of infestation on the Beaverhead Forest. In 1932 on some of the units where the infestation had been extremely heavy for a long period there was a decrease in infestation due to shortage of host material. As similar conditions existed on other parts of the forest, a slight reduction in the total number of infested trees was expected in connection with the 1933 attacks. However, the tremendous reduction that did occur was entirely unexpected, and was assumed to be due chiefly to destruction of the overwintering stages of the insect during the severe cold spells of the preceding winter. The status of the general infestation is clearly seen in the brief tabulation which follows:

CHANGES IN MOUNTAIN PINE BEETLE INFESTATION
BEAVERHEAD NATIONAL FOREST

Number of attacked trees in

	1927 (1)	1928	1929	1930	1931	1932	1933
	67,691	722,504	3,119,542	4,898,326	15,402,520	17,586,171	869,647
Inc.	-	654,813	2,397,038	1,778,784	10,504,194	2,183,651	-
Dec.	-	-	-	-	-	-	16,716,524

(1) Estimate considered to have been too conservative; also 55,045 of these trees were treated in 1928. All data subsequent to 1927 corrected for effect of differences in date of survey on total infestation.

The figures given for 1927 are for the infested trees on the original control unit acreage, while those for succeeding years give the larger figures pertaining to the increased acreages. The revision of the 1927 estimate of number of attacks was not attempted due to the belief that it would create an estimate of uncertain value. Subsequent to 1927 the distribution of the infestation was more uniform, and the revised estimates probably closely approach the actual figures. It must be emphasized that leaving the 1927 estimate untouched and revising the one for 1928 gives an inflated value for the increase from 1927 to 1928. The infestation in 1928 would have been even greater had it not been for the treatment of 55,045 trees of the 1927 infestation.

A more detailed estimate of the number of attacked trees on each unit is given in Tables I and II. A study of the data for the different units shows that except for comparatively minor decreases on three units in 1930 increases occurred on all units every year until 1932. In that year there was a reduction in the number of attacks on five of the units, due, we believe, to a shortage of host material as a result of the heavy losses for a period of four years. Four of these units, which showed decided reductions, are in the northwestern portion of the forest, where the outbreak first caused serious losses. The infestation has since been advancing to the southeast and eastern portions of the forest, but did not destroy many trees in that region until 1931. From Table II it may be seen that the factor which caused such a decided reduction in number of attacks in 1932-33 on the northern part of the forest seems to have been less effective on the more recently infested units to the southeast. The following explanations are offered for these differences:

(1) On the northwestern units the small trees which are left offer high resistance to attack and unfavorable conditions for development of the bark beetles. In contrast, on the southeastern units there is still an abundance of larger host material less resistant to attack and more favorable to development of the insect.

(2) The smaller trees on the units in the northwest portion of the forest have thinner bark and less volume to retard extreme changes in temperature, which may cause the death of bark-beetle brood, than the larger, thicker-barked trees on the southeast part.

(3) The more level topography of the units in the northwest portion of the forest and the big central basin which they adjoin favors the formation of colder temperatures than would be experienced on the rougher topography of the units to the southeast. Mr. Lathrop

of the Weather Bureau states that under certain conditions lower temperatures occur in low basin-like areas than at the higher altitudes.

(4) Natural enemies of the mountain pine beetle were probably more plentiful, could reach more readily and take heavier toll of the beetle brood under the thinner bark of the smaller trees on the northwestern units than under the thicker bark of the larger trees in the southeast part of the forest.

(5) Other obscure factors may have contributed both to the reduction in infestation and the differences in decrease noted on the two parts of the forest.

Table II shows the annual losses on each unit for the average acre during the period from 1927 to 1935. A wide variation is noted in the amount of loss per acre for the various units. These differences are due in many cases not to variations in degree of kill but to differences in the number, age, and species of trees on the average acre. Where much of the acreage of a unit is untimbered and the timbered part contains a large proportion of unsusceptible species, the average number of trees per acre that can be attacked is comparatively small, and light losses will be indicated. However, it must be pointed out that on such units there may be just as heavy a proportionate loss of susceptible trees as on the units supporting an almost unbroken stand of timber. In Table III may be seen the total losses per average acre for each of the units on the Beaverhead Forest up to the present time. These data can not be considered as giving the final losses on any of the units, although on the units in the northwestern part of the forest they may closely approach the total direct losses that will result from the infestation. On the eastern units there is still a vast amount of timber of susceptible size, and losses can be expected to be much higher if the infestation builds up again. Units on which there may be heavy losses in the future are Upper and Lower Wise River, Melrose, Grasshopper, and Rattlesnake.

In Tables I, II, and III all data secured subsequent to 1927 have been corrected for the differences in percent of total attacks at the time of survey and the final number in a season, and for the total acreage on each unit. To secure this correction factor permanent sample strips were examined at intervals during the period of attack by the mountain pine beetle for the three years from 1931 to 1933. The data secured are shown in Table IV and Chart I.

TABLE I

SUMMARY SHEET--BEAVERHEAD FOREST SURVEY--1933

Comparison of the Infestation from 1927 to 1933 Caused by the Mountain Pine Beetle in Lodgepole Pine

Unit	Trees treated in 1927	Acreage	Estimated Number of Attacked Trees 1928	1929	1930	1931	1932	1933
Pintler	11,527	61,600	101,398	490,200	447,253	762,485	667,732	37,167
Mussigbrod	12,479	56,300	165,857	443,909	528,665	1,336,675	1,424,904	12,085
Battlefield	3,454	102,400	127,092	627,013	1,755,245	4,445,696	2,471,203	37,895
West Side		76,500	60,184	368,262	534,719	2,031,534	1,468,693	52,129
Jackson	2,908	75,800	67,571	345,886	559,986	1,404,498	1,730,767	51,279
Bloody Dick	/	108,160	55,568	177,110	336,792	1,551,339	2,796,036	55,603
Horse Prairie		57,000	30,602	183,824	34,227	167,124	93,525	32,092
Rattlesnake		68,400	4,050	16,985	8,396	117,990	513,334	63,915
Grasshopper		42,500	673	3,800	14,173	91,587	574,034	12,455
Warm Springs		54,500	22,966	95,268	127,142	1,135,856	1,736,678	42,241
East Side	21,110	86,200	68,411	302,780	432,488	1,519,783	660,867	13,403
Upper Wise River		142,800	11,940	21,461	27,177	408,694	1,166,162	150,316
Lower Wise River	3,567	59,000	6,191	28,294	68,694	231,068	893,323	133,578
Melrose		132,700			10,368	134,847	1,182,491	110,919
Lima		218,000		14,750	13,001	63,344	206,422	64,570
TOTALS	55,045	1,341,860	722,504	3,119,542	4,898,326	15,402,520	17,586,171	869,647

TABLE II
Comparison of Attacked Trees per Acre and Percent of Increase Each Year for Period 1927 to 1933--Beaverhead Forest Survey
Mountain Pine Beetle in Lodgepole Pine--1933

	1927		1928		1929		1930		1931		1932		1933	
SubUnit	Att. trees per acre	%Chng. over prev. year	:Att. :trees :per :acre	%Chng. over prev. year	:Att. :trees :per :acre	%Chng. over prev. year	:Att. :trees :per :acre	%Chng. over prev. year	:Att. :trees :per :acre	%Chng. over prev. year	:Att. :trees :per :acre	%Chng. over prev. year	:Att. :trees :per :acre	%Chng. over prev. year
Pintler	.530	--	1.647	211	7.960	383	7.263	-8.8	12.380	70.4	10.084	-18.5	.603	-94.0
Mussigbrod	.610	--	2.947	383	7.883	167	9.391	19.1	23.740	152.8	25.320	6.7	.215	-99.2
Battlefield	.093	--	1.241	1234	6.122	393	17.144	180.0	43.420	153.3	24.130	-44.4	.370	-98.5
West Side	--	--	.786	--	4.815	513	6.990	45.2	26.556	279.9	19.210	-27.7	.681	-96.5
Jackson	.103	--	.891	765	4.564	412	7.387	61.9	18.525	150.8	22.836	23.3	.676	-97.0
Bloody Dick	--	--	.514	--	1.638	219	3.116	90.2	14.340	360.2	25.853	80.3	.514	-98.0
Horse Prairie	--	--	.537	--	3.226	501	.601	-81.4	2.932	387.9	1.641	-44.0	.563	-65.7
Rattlesnake	--	--	.059	--	.248	320	.123	-50.4	1.724	1301.6	7.504	335.3	.934	-87.6
Grasshopper	--	--	.015	--	.069	360	.334	384.1	2.155	545.2	13.520	527.4	.341	-97.5
Warm Springs	--	--	.421	--	1.748	315	2.333	33.5	20.852	793.8	31.881	52.9	.775	-97.6
East Side	.428	--	.794	86	3.513	342	5.017	42.8	17.626	251.3	7.666	-56.5	.064	-99.2
Upper Wise R.	--	--	.084	--	.150	79	.190	26.7	2.862	1406.3	8.167	185.3	1.050	-87.1
Lower Wise R.	.058	--	.105	81	.479	356	1.164	143.0	3.916	236.4	15.134	286.5	2.264	-85.0
Melrose	--	--	--	--	--	--	.078	--	1.017	1203.8	8.913	776.4	.836	-90.6
Lima	--	--	--	--	.068	--	.060	-11.8	.291	385.0	.947	225.4	.296	-68.7
AVERAGES	.088	--	.539	512.5	2.325	331.4	3.650	57.0	11.478	214.5	13.106	14.2	.648	-95.1

TABLE III

Average Number of Trees Killed per Acre on Each Unit by the Mountain Pine Beetle--Period 1927-1933--Beaverhead National Forest

Unit	Total trees killed per acre 1927-33
Pintlar	40.47
Mussigbrod	70.11
Battlefield	92.52
West Side	59.04
Jackson	54.98
Bloody Dick	45.97
Horse Prairie	9.50
Rattlesnake	10.59
Grasshopper	16.43
Warm Springs	58.01
East Side	35.11
Upper Wise River	12.50
Lower Wise River	23.12
Melrose	10.84
Lima	1.66
Average for Forest	31.83

TABLE IV

Average Percent of Total Number of Attacks for Certain Dates in 1931, 1932, and 1933--Mountain Pine Beetle in Lodgepole Pine, Beaverhead National Forest

Average % of attacks on	8/7	8/10	8/15	8/20	8/25	9/1	9/15	9/30	10/5	10/30
1933 data	50.5	55.5	64	72.5	79	86	93.5	98	99	100
1932 data	33	42.7	66	79	85	89.5	93	94	96	100
1931 data	60	65	72.5	79	84	90	96	99	99	100
Average	47.8	54.4	67.5	76.8	82.7	88.5	94.2	97.0	98.0	100.0
Max. % of variation of any year from the average	-31.0	-21.5	+7.4	-5.6	-4.5	-2.8	+3.0	-3.1	-2.1	

Providing the data for the three years are representative, the preceding table indicates that after August 15 the percent of the total attack any date of any year can be very closely estimated; the maximum error would not be over 7.5 percent, and decreases as the season advances. As only a very small proportion of the total survey is made prior to August 15, the possible error resulting from correcting any year's data with the average for the three years seems very slight. Therefore, we can see that survey data collected subsequent to August 15 and corrected with the average for the three years will probably show very little deviation from actual conditions. It is not known if this correction factor used on the Beaverhead could be applied to areas of lodgepole pine on other forests, but it is probable that where conditions are quite similar it would be sufficiently accurate to be of considerable value.

THE BATTLEFIELD CHECK STRIP

In order to compare conditions on the three permanent check strips, the data from each will be considered separately. Previously it has been stated that the infestation has been present for the longest period and caused the heaviest losses on the Battlefield strip. On this strip there is also a larger percent of the trees showing damaged or one-sided attacks. In Table V the data from the Battlefield strip is shown in condensed form. It may be seen that in spite of the few trees killed by the mountain pine beetle on this strip in 1933 the total of attacked trees for that year was quite high due to the large number killed by secondary insects. In 1933 many trees attacked by insufficient *Dendroctonus monticolae* to cause the death of the trees were "filled in" by the secondary insects and killed. In addition, these usually secondary insects were primary killers of more trees than both *Dendroctonus monticolae* and that insect and Ips combined in 1933. The trees killed in 1933 were chiefly of the smaller diameter classes, evidenced by an average diameter of 7.8 inches for trees killed to 1933, a reduction from an average diameter of 8.5 for 1932; the damaged trees (green-sided and pitched-out) average about 7.3 inches. On the basis of the number of trees 1 inch or over in diameter killed up to November, 1933, the loss is light, being only about **18.0 percent** and **72.1 percent** of the stand remains as undamaged trees. The trees killed, however, averaged about 2½ times the diameter of the undamaged lodgepole pine. Because comparisons by diameters give a distorted value, the data have also been compared on the basis of basal areas in Chart II, which in

TABLE V

Changes in the Stand on the Battlefield Check Strip Due to a Mountain Pine Beetle Infestation in Lodgepole Pine--Beaverhead National Forest--
Based on 36.0 Acres of Strip, of which 35.1 are Timbered

DBH Classes	2	4	6	8	10	12	14	16	18	20	22	Total	% of original stand	Sq.Ft. of basal area	% of original basal area	Average DBH
								Status of Stand Prior to Infestation								
DF	476	114	76	29	38	10	9	-	-	10	9	771	1.7	129.14	2.1	4.0
Other sp.	181	146	45	67	11	-	-	-	-	-	-	450	1.1	54.91	.9	4.1
LP	19,726	9,876	6,447	4,430	1,873	614	342	38	29	-	1 YP	43,376	97.2	6,079.86	97.0	4.3
Total	20,383	10,136	6,568	4,526	1,922	624	351	38	29	10	10	44,597	100.0	6,263.91	100.0	4.3
Lodgepole								**Status in 1931**								
Green	19,726	9,768	4,359	1,432	358	63	-	-	-	-	1 YP	35,707	80.0	2,885.70	46.1	3.4
Killed	-	48	518	1,205	1,280	514	324	38	29	-	-	3,956	8.9	2,078.52	33.2	9.5
Green-sided	-	10	165	553	194	29	10	-	-	-	-	961	2.1	365.49	5.8	8.2
Pitched-out	-	50	1,405	1,240	41	8	8	-	-	-	-	2,752	6.2	750.15	12.0	7.0
Lodgepole								**Status in 1932**								
Green	19,720	9,326	3,265	907	215	-	-	-	-	-	-	33,433	75.0	2,318.90	37.0	3.2
Killed	2	441	1,554	1,687	1,421	590	332	38	29	-	1 YP	6,095	13.6	2,632.23	42.0	8.5
Green-sided	1	32	183	576	202	17	6	-	-	-	-	1,017	2.3	369.66	5.9	8.0
Pitched-out	3	77	1,445	1,260	35	7	4	-	-	-	-	2,831	6.3	759.07	12.1	6.9
Lodgepole								**Status in 1933**								
Green	19,543	8,904	2,655	892	175	-	-	-	-	-	-	32,169	72.1	2,131.41	34.0	3.1
Killed by D.m.	2	442	1,556	1,689	1,424	592	332	38	29	-	1 YP	6,105	13.7	2,636.61	42.1	8.5
Killed by Ips and D.m.	3	183	452	171	71	22	1	-	-	-	-	903	2.0	221.51	3.5	6.4
Killed by Ips sp.	176	343	499	7	2	-	-	-	-	-	-	1,027	2.3	135.28	2.2	4.7
Green-sided	2	-	-	579	169	-	6	-	-	-	-	756	1.7	300.66	4.8	8.5
Pitched-out	-	4	1,285	1,092	32	-	3	-	-	-	-	2,416	5.4	654.39	10.4	7.0

this case is believed to give a better indication of the seriousness of the losses. Compared in that manner, we find *47.8 percent* of the original stand killed and another 15.2 percent damaged up to the present time, *leaving 34.0 percent* of the basal area of lodgepole pine undamaged. Species other than lodgepole pine (Douglas fir, alpine fir, Engelmann spruce, yellow pine and whitebark pine) composed only 2.8 percent of the *number*, or 3.4 percent of the *basal area* of the original stand. The percent which these other species are of the remaining undamaged stand has risen with the destruction of so many lodgepole pine from 3.0 percent to 7.9 percent of the basal area. This change indicates how a bark-beetle epidemic may change the composition of a stand. Where unsusceptible species make up a larger proportion of the original stand, the changes are even more striking. The small original percent of unsusceptible species on the Battlefield area prevents them from materially affecting the composition of the future stand.

Judging from conditions observed in 1933, secondary insects survived the extreme temperatures of the preceding winter in much greater numbers than the primary mountain pine beetle. For this reason *Dendroctonus monticolae*-attacked trees in 1933 were apparently too few to supply the necessary upper bole and branch material needed by these secondary insects for their development. Therefore, they assumed the role of primary killers, invaded many small trees and numerous green-sided and pitched-out trees attacked in 1932 which might have survived but for their attacks. In addition, they filled in and killed many lightly *Dendroctonus monticolae*-attacked trees in 1933 which would probably have survived but for these secondary insects.

In 1934 it is probable that additional trees will be killed by these secondary Ips, but it is not known whether they will be as important as in 1933. Vast numbers of cerambycids and buprestids have also developed in the millions of dead trees. The role that they will play in the future is uncertain because of the great reduction in material in which they can develop. There is a possibility that they too will "fill in" many of the trees being attacked by Dendroctonus monticolae and destroy the food of the mountain pine beetle before the brood can develop. If such a condition develops, they too will aid in reducing the numbers of the mountain pine beetle. Blackman mentions (2) the adverse effect of the larvae of certain cerambycids "upon brood survival of the Black Hills beetle, by robbing the bark beetles of their food, by destroying them bodily, and by loosening the bark and thus aiding in its desiccation." He also stated, however, that the cerambycid larvae seemed, in the case of epidemics of the Black Hills beetle, to be affected by the same conditions that caused the increase or decrease of the bark beetles. If a similar correlation exists between Dendroctonus monticolae and cerambycids on the Beaverhead, we may expect no change in the control effect of the latter.

Further inspection of Table V indicates that the trees in the 4- and 6-inch diameter classes suffered the greater mortality on the Battlefield strip in 1933 due to the activities of Ips sp. Many trees in which the mountain pine beetle had succeeded in killing one or more sides and others which had "pitched-out" the **Dendroctonus monticolae** attacks succumbed to the secondary insects. Toll taken of the remaining green trees by Ips sp. was fairly heavy and varied but little between the smaller and larger classes.

---

(2) Technical Publication No. 36, New York State College of Forestry. Blackman.

The residual stand of unattacked trees per acre on the Battlefield check strip up to the present time is as follows: lodgepole pine from 1 to 5 inches in diameter, 790 trees per acre; from 5 to 11 inches in diameter, 103 trees per acre; of all species of all diameters other than lodgepole pine, 34 per acre; making a total of 927 trees per average acre. The losses likely to occur from insect attacks are not expected to seriously deplete this remaining stand. Losses indirectly assignable to the infestation such as windthrow, windbreaks, snowbreak, and destruction caused by falling insect-killed trees can be expected for many years, but these are not expected to materially reduce the remaining stand. Losses from fires, possibilities of which have been greatly increased by the dead timber, are the greatest menace to the future stand. Table VI shows the status of the stand by percent of the original number for each inch class.

TABLE VI

Status of Trees in Each Inch Class--The Figures Give the Percent of Trees in Each Condition to November, 1933, on the Battlefield Check Strip--Beaverhead National Forest

DBH Classes	2	4	6	8	10	12	14	16	18	20	22
Unatt. D.F. & other sp.	3.22	2.57	1.84	2.12	2.55	1.60	2.57	---	---	100	100
LP unatt.	95.88	87.84	40.42	19.72	9.11	---	---	---	---	---	---
Killed	.89	9.55	38.16	41.24	77.88	98.40	94.87	100	100	---	---
Green-sided	.01	---	---	12.80	8.79	---	1.71	---	---	---	---
Pitched-out	---	.04	19.57	24.12	1.67	---	.85	---	---	---	---

The role of Ips in the 1933 attacks on the Battlefield unit was an important one compared with the destruction caused by *Dendroctonus monticolae*. Ips caused the death of 2,021 trees on the strip, while *Dendroctonus monticolae* killed only 19. Ips found most of the trees which had "pitched-out" *Dendroctonus monticolae* attacks the year previous undesirable. If the data can be considered an indication, green trees were preferred to the pitched-out trees in the ratio of 4½ to 1, as they took 444 unattacked green trees and only 97 pitched-out.

Ips on the Beaverhead in 1933 had completed most of the attacks for the season by early July, according to the data from the Battlefield strip. By July 7 over 89 percent of the total trees to be attacked by Ips during the season had been infested. Subsequent to July 7 all attacks were confined to green trees or trees which had been lightly attacked by Ips during the current season. A few attacks by Ips occurred between September 7 and October 11, 1933.

THE WISE RIVER CHECK STRIP

Analysis of the data from the Wise River check strip indicated considerable difference when compared with conditions on the Battlefield strip. Ips were the primary or contributing cause of death of over 99 percent of the trees killed on the Battlefield strip in 1933, in contrast to 82 percent on the Wise River check strip. Outstanding differences in conditions on the two strips probably account for the discrepancies just discussed. One difference is that the infestation has been causing serious losses on the Battlefield area since 1928, but did not reach a similar status on the Lower Wise River area until 1930, thus resulting in host material being much more limited on the Battlefield area and the remaining stand unfavorable to mountain pine beetle development. On the Wise River area host material is still relatively plentiful and of larger diameter, which seems to offer much better conditions for mountain pine beetle development. These differences in host supply and resistance are reflected in the relative emergence in each area, it having been observed that a smaller emergence of mountain pine beetles occurred per unit of bark surface on the Battlefield area than on the Wise River drainage. In addition to the above, the much longer period of heavy losses on the Battlefield area has favored the production of a tremendous number of secondary insects in the portions of the trees not attacked by the mountain pine beetle. The apparent greater survival of these secondaries was reflected in the confining of losses almost entirely to them in 1933. Losses on the Wise River drainage from these secondary insects was not as heavy, whereas losses from the mountain pine beetle were proportionately much heavier than on the Battlefield unit.

Further analysis of the data which is shown in Table VII and Chart III indicates considerable timber of the larger-diameter classes still present on the Wise River area. On the Battlefield strip no undamaged trees remain which are over 11 inches in diameter, while on the Wise River strip 17.5 percent of the original number in that class are still unattacked.

How much the difference in stand composition on the Wise River strip will affect losses is not known. Lodgepole pine comprises slightly over 74 percent of the total number of trees and slightly over 65 percent of the total basal area of the unit. The mixture of Douglas fir assures us of lighter final losses on this strip than on the Battlefield area, and

TABLE VII

Status of the Stand on the Wise River Check Strip--Mountain Pine Beetle in Lodgepole Pine--
Beaverhead National Forest-1933

Based on 40.0 Acres of Strip, of which 33.0 Acres were Timbered with Conifers, .5 Acres with Aspen, and 6.5 Acres Open

Status of Stand Prior to Infestation

DBH Classes:	2	4	6	8	10	12	14	16	18	20	22	24	26	Total	% of original stand	Sq.Ft.of basal area	% of original basal area	Average DBH
DF	2,484	1,481	640	392	256	325	186	133	29	18	-	9	9	5,962	21.2	1,377.24	31.8	5.1
Other sp.	348	545	352	-	-	-	-	-	-	-	-	-	-	1,245	4.4	124.26	2.9	4.0
Original LP	8,526	7,057	2,214	1,874	584	402	203	31	28	-	-	-	-	20,919	74.4	2,834.50	65.3	4.2
Total	11,358	9,083	3,206	2,266	840	727	389	164	57	18	-	9	9	28,126	100.0	4,336.00	100.0	4.4
Lodgepole							Status in 1931											
Green	8,526	7,057	2,209	1,836	558	341	123	31	28	-	-	-	-	20,709	73.7	2,672.67	61.6	4.1
Killed	-	-	5	38	14	47	80	-	-	-	-	-	-	184	.7	144.29	3.3	11.7
Green-sided	-	-	-	-	12	-	-	-	-	-	-	-	-	12	-	6.54	.1	10.0
Pitched-out	-	-	-	-	-	14	-	-	-	-	-	-	-	14	-	11.00	.3	12.0
Lodgep							Status in 1932											
Lodgepole							Status in 1932											
Green	8,526	7,043	2,027	1,279	193	69	47	4	9	-	-	-	-	19,197	68.3	1,876.18	43.3	3.7
Killed	-	10	126	484	339	295	155	26	19	-	-	-	-	1,454	5.2	846.58	19.5	10.0
Green-sided	-	1	17	32	24	7	-	-	-	-	-	-	-	81	.3	33.18	.8	8.5
Pitched-out	-	3	44	79	28	31	1	1	-	-	-	-	-	187	.7	78.55	1.8	8.5
Lodgepole							Status in 1933											
Green	8,504	7,021	2,005	1,233	173	60	43	4	9	-	-	-	-	19,052	67.7	1,831.19	42.2	3.7
Killed by *D.m.*	-	11	136	504	355	302	155	26	19	-	-	-	-	1,508	5.4	869.83	20.1	10.0
Killed by *D.m.*&Ips	4	8	41	75	38	16	2	-	-	-	-	-	-	184	.7	70.47	1.6	8.2
Killed by Ips sp.	18	16	12	5	1	4	3	-	-	-	-	-	-	59	.2	12.80	.3	5.3
Green-sided	-	-	1	5	1	1	-	-	-	-	-	-	-	8	-	3.29	.1	8.5
Pitched-out	-	1	19	52	16	19	-	1	-	-	-	-	-	108	.4	47.01	1.1	8.7

TABLE VIII

Status of the Stand on the Elkhorn Check Strip--Mountain Pine Beetle in Lodgepole Pine-- Beaverhead National Forest-1933

Based on 36.0 Acres of Strip, of which 28.1 Acres are Timbered

Status of Stand Prior to Infestation

DBH Classes	2	4	6	8	10	12	14	16	18	20	22	24	26	28	Total	% of orig. stand	Sq.Ft.of basal area	% of original basal area	Average DBH
DF	23	6	-	-	11	-	-	-	-	-	-	4	-	4	48	.1	36.68	.86	8.1
Other sp.	297	123	11	6	-	-	-	-	-	-	-	-	-	-	437	1.1	21.47	.50	2.7
Original LP	19,217	10,504	4,170	2,016	691	567	213	170	19	7	-	-	8	-	37,582	98.8	4,223.67	98.64	3.8
Total	19,537	10,633	4,181	2,022	702	567	213	170	19	7	-	4	8	4	38,067	100.0	4,281.82	100.0	3.8
Lodgepole									Status in 1931										
Green	19,217	10,504	4,160	2,016	685	541	213	151	19	7	-	-	8	-	37,521	98.7	4,171.49	97.43	3.8
Killed	-	-	10	-	6	17	-	19	-	-	-	-	-	-	52	.1	45.11	1.04	12.1
Green-sided	-	-	-	-	-	9	-	-	-	-	-	-	-	-	9	-	7.07	.17	12.0
Pitched-out	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lodgepole									**Status in 1932**										
Green	19,217	10,504	4,114	1,907	594	440	121	116	-	-	-	-	-	-	37,013	97.3	3,769.94	89.24	3.7
Killed	-	-	42	88	77	106	89	53	19	7	-	-	8	-	489	1.3	411.67	9.75	11.8
Green-sided	-	-	8	7	3	13	-	-	-	-	-	-	-	-	31	.1	15.86	.38	9.4
Pitched-out	-	-	6	14	17	8	3	1	-	-	-	-	-	-	49	.1	26.78	.63	9.6
Lodgepole									**Status in 1933**										
Green	19,216	10,501	4,104	1,881	572	421	117	116	-	-	-	-	-	-	36,929	97.1	3,727.44	88.26	3.6
Killed by D.m.	1	-	44	102	95	120	92	53	19	7	-	-	8	-	540	1.4	440.99	10.44	11.7
Killed by D.m.&Ips		-	10	21	18	20	-	-	-	-	-	-	-	-	69	.2	34.81	.82	9.4
Killed by Ips	-	3	2	1	-	-	-	-	-	-	-	-	-	-	6	-	1.00	.02	5.3
Green-sided	-	-	2	5	3	3	1	-	-	-	-	-	-	-	14	-	7.21	.17	9.4
Pitched-out	-	-	8	6	3	3	3	1	-	-	-	-	-	-	24	.1	12.27	.29	9.2

there is also the possibility that the unsusceptible Douglas fir may protect some of the lodgepole which might be killed in a pure lodgepole stand.

Losses from *Dendroctonus monticolae* on the Wise River unit will probably increase in 1934 due to more favorable conditions for development of the insects. Losses from Ips for 1934 are difficult to forecast due to uncertainty of the effect of the decrease in 1932-33.

THE ELKHORN CHECK STRIP

Losses on this strip, as Table VIII and Chart IV indicate, have been the lightest of the three strips. Less than 2 percent of the number of trees on the strip have been killed or damaged by the insects. The attacks, however, having been chiefly in the large-diameter trees, amount to nearly 12 percent of the basal area of the stand. The stand on the Elkhorn strip resembles that of the Battlefield unit in the high proportion of lodgepole pine, and differs only in that the latter strip has over 50 percent mobe trees in the 6-to 14-inch classes.

The mountain pine beetle killed about the same number of trees on the Elkhorn as on the Wise River strip in 1933, but secondary insects were found in only 30 percent as many trees on the Elkhorn strip. Up to the present Ips have not been an important factor on the Elkhorn unit, but mild weather during the winter of 1933-34 may cause decided increases in the attacks by both primary and secondary insects in 1934.

In summarizing the status of the stands on the three check strips, which are believed to be fairly representative of the areas in which they lie, it is evident that the outbreak is not likely to cause much further direct loss on the Battlefield strip, on the Wise River area the losses can still be quite heavy, while on the Elkhorn unit most of the timber of a size susceptible to attack is still unattacked.

On all three strips an average of more than 85 percent of the attacks by Ips had occurred by the end of July, as near as could be estimated from the dates ~~and~~ the strips were examined. The effect of the lighter infestation in 1933 on success of attacks can be judged by the fact that of the trees attacked by Dendroctonus monticolae in 1932, 84.7 percent were killed and 15.2 percent damaged, while in 1933 only 61.7 percent were killed and 38.3 percent damaged.

That the larger trees are preferred and are the first to be taken by the insects is shown by the decrease in the average diameter of the trees killed each year. The average diameter of the trees killed is shown in the following tabulation:

Average DBH of Trees Killed
on the Permanent Sample Strips

DBH of Trees Killed to	Strip Battlefield	Wise River	Elkhorn
1931	9.5	11.7	12.1
1932	8.5	10.0	11.8
1933	7.8	9.7	11.4

The writer does not wish to convey the idea that no small trees are attacked. Many are, but the larger trees in the stand comprise the majority of those attacked.

STATUS OF THE INFESTATION ON EACH UNIT

Although a general discussion of the status of the Beaverhead outbreak follows the tables in the first part of this report, it is believed a more detailed description of conditions on each unit will lead to a clearer understanding of the development of the infestation on the Beaverhead Forest.

Pintler Unit
Acreage 61,600

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.530	1.647	7.960	7.263	12.380	10.084	.603	40.467
Att. trees on unit	11,527	101,399	490,200	447,253	762,485	667,732	37,167	2,517,763
% change over prev. year	---	211	383	-8.8	70.4	-13.5	-94.0	---

The area included in this unit supported a heavy infestation for the five years from 1928 to 1932. Although the outbreak decreased in 1932 and would probably have shown an even more marked decline in 1933, the factor or factors which reduced the infestation over the entire forest must be credited with the major portion of the reduction. A surprising condition noted on this unit, and on others as well, is the occurrence of "islands" of timber showing few, if any, killed trees in the midst of vast areas where the destruction has been extremely high. There are no indications to account for this immunity, as site and other conditions do not seem to differ from the severely devastated areas. There is a possibility that chance alone is the reason these groups of trees have not been attacked. If these areas remain unattacked, a study of the reasons for it may be a profitable one.

Such a large portion of the stand has been killed on this unit that the infestation can not build up again to the point where it can cause very heavy losses by the same agency. In the near future losses will probably be light, although they may be much heavier than in 1933.

Mussigbrod Unit
Acreage 56,300

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.610	2.947	7.683	9.391	23.740	25.320	.215	70.106
Att. trees on unit	12,479	165,857	443,909	528,665	1,336,675	1,424,904	12,085	3,924,574
% change over prev. year	---	383	167	19.1	152.8	6.7	-99.2	---

A heavier average stand per acre, due in part to less untimbered acreage than on the Pintler unit, is the main reason for the heavier losses on this area.

The heavy toll already taken by the insects on this unit precludes heavy future losses even though some increase over the 1933 figure may occur.

Battlefield Unit
Acreage 102,400

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.093	1.241	6.122	17.144	43.420	24.130	.370	92.520
Att. trees on unit	3,454	127,092	627,013	1,755,245	4,445,696	2,471,203	37,895	9,467,598
% change over prev. year	---	1234	393	180.0	153.3	-44.4	-98.5	---

A dense, continuous stand of susceptible timber and a heavy infestation for five years has favored the heaviest loss from the outbreak of any unit on the forest. It seems almost incredible that after losing an average of 92.5 trees per acre there should still be living trees on this unit. Indeed, many extensive areas of mature lodgepole show only an occasional green crown against the background of killed trees, but in the stands of small-diameter trees losses have not been so serious. Extensive areas of timber on this unit with a high percent of kill will probably result in the highest fire hazard on any part of the forest, to continue for many decades.

Future losses should be comparatively light on this unit due to the small average diameter of the remaining timber, which is apparently so unfavorable to bark-beetle development.

West Side Unit
Acreage 76,500

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	---	.786	4.815	6.990	26.556	19.210	.681	59.038
Att. trees on unit	---	60,134	368,262	534,719	2,031,534	1,468,693	52,129	4,515,521
% change over prev. year	---	---	511	45.2	279.9	-27.7	-96.5	---

The decrease in infestation on this unit in 1932 indicated that the peak of losses had been reached the preceding year. While the 1933 attacks were, of course, abnormally few, it can be said with reasonable certainty that future annual losses can not again even approach those of 1932, due to increasing resistance and decreasing supply of host material.

Jackson Unit
Acreage 75,800

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.103	.891	4.564	7.387	18.523	22.836	.676	54.980
Att. trees on unit	2,908	67,571	345,886	559,986	1,404,498	1,730,767	51,279	4,162,895
% change over prev. year	---	765	412	61.9	150.8	23.3	-97.0	---

Although this unit showed an increase in infestation in 1932, the amount was small and seems to warrant the statement that the peak of losses was reached on that area in 1932. Future annual losses from the mountain pine beetle should never approach those of 1932, and will probably be very much lighter.

Bloody Dick Unit
Acreage 108,160

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.514	1.638	3.116	14.340	25.853	.514	45.975
Att. trees on unit	55,568	177,110	336,792	1,551,339	2,796,036	55,603	4,972,448
% change over prev. year	---	219	90.2	360.2	80.3	-98.0	---

Annual losses on this unit probably reached their peak in 1932 regardless of the agency causing the abnormal decrease in 1933. Although in the near future an increase in annual losses may occur from the low of 1933, it will never approach the amount for 1932, as there is insufficient susceptible material remaining to support such an increase.

Horse Prairie Unit

Acreage 57,000

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.537	3.226	.601	2.932	1.641	.563	9.500
Att. trees on unit	30,602	183,824	34,227	167,124	93,525	32,092	541,394
% change over prev. year	---	501	-81.4	387.9	-44.0	-65.7	---

The data secured from the surveys of this unit indicate wide fluctuations in the amount of infestation each year. Two conditions may account for these variations. The scattered and comparatively isolated patches of susceptible timber on this unit may interfere with increases in insects normal to continuous bodies of timber and be chiefly affected by heavy flights of beetles from outside sources. It is suggested that in continuous bodies of timber probably less mortality occurs when emerging insects fly to infest distant trees than where they must fly the same distance across open country. In the latter case it is probable that predators, high winds and other factors take a higher toll of the insects than where flights are confined to the shelter of timber. A second possibility suggesting the reason for these annual variations in amount of infestation is that the small amount of data secured for this unit may not be representative of actual conditions. More data might show that no such differences exist or that they are much less than present data indicate.

The comparative figure for total loss per acre up to the present time is extremely low not because the infestation has been light on this unit but due to a large amount of untimbered area placing the average stand per acre at a low figure. Losses have been very severe in the timbered portions of this unit. Indications are that future annual losses will be comparatively light, although they may build up to a higher figure than for 1933.

Lima Unit
Acreage

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	---	.068	.060	.291	.947	.296	1.662
Att. trees on unit	---	14,750	13,001	63,344	206,422	64,570	362,087
% change over prev. year	---	---	-11.8	385.0	225.4	-68.7	---

Losses on this unit have seemed light in comparison with other units; however, very little of this unit is timbered, and much of the timbered portion contains unsusceptible species. The peak of losses reached in 1932 is not likely to be reached again on this unit, as outside sources of infestation, which are believed to have been the main cause of the losses on this unit, no longer support a very heavy outbreak.

An unusual feature of the infestation on both the Horse Prairie and Lima units in 1933 was the fact that the reductions were but 66 and 69 percent respectively compared with a minimum of 85 percent for the least decrease on any of the other units. The only suggestions the writer can offer for these differences are that these two units may have been either on the outer edge of the cold wave and temperatures were not as severe as elsewhere on the Beaverhead, or that most of the timbered area on these units being well above the surrounding untimbered country temperatures were higher than at the lower elevations. A third possibility is that the data secured are not representative of actual conditions.

Rattlesnake Unit
Acreage 68,400

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.059	.248	.123	1.724	7.504	.934	10.592
Att. trees on unit	4,050	16,985	8,396	117,990	513,334	63,915	725,670
% change over prev. year	---	320	-50.4	1301.6	335.3	-87.6	---

It is believed the peak of annual losses was not reached on this unit in 1932, as this area did not show a serious infestation until 1931. Unless some agency interferes it is believed the infestation will gradually build up on this and nearby units for a number of years.

Melrose Unit
Acreage 132,700

Survey Record	1930	1931	1932	1933	Total
Att. trees per strip acre	.078	1.017	8.913	.836	10.844
Att. trees on unit	10,368	134,847	1,182,491	110,919	1,438,625
% change over prev. year	---	1203.8	776.4	-90.6	---

The status of the infestations on this unit is similar to that on the Rattlesnake and other adjoining units, with the main reason for the rapid increase in annual losses being due to migration of beetles from more heavily infested areas. The heavy reduction in the outbreak over the forest as a whole will probably prevent these previous sources of supply from contributing to any great extent in the near future to the infestation already present on the Melrose unit. Therefore, the increase in annual losses which we can expect on this area in the next few years should be more gradual than prior to 1932. There is ample mature timber on this unit to support an epidemic for a number of years.

Grasshopper Unit
Acreage 42,500

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.015	.069	.334	2.155	13.520	12,341	16,434
Att. trees on unit	673	3,800	14,173	91,587	574,034	12,455	696,722
% change over prev. year	---	360	384.1	545.2	527.4	-97.5	---

Severe loss only in 1932 leaves a great deal of mature timber in which the infestation can build up on this unit. Barring the intervention of some agency, annual losses should gradually increase on this unit for a number of years.

Upper Wise River Unit
Acreage 142,800

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.084	.150	.190	2.862	8.168	1.050	12.504
Att. trees on unit	11,940	21,461	27,177	408,694	1,166,162	150,316	1,785,750
% change over prev. year	---	79	26.7	1406.3	185.3	-87.1	---

Considerable unattacked mature timber remains on this unit to serve as host material for an infestation which, it is believed, will increase for a number of years unless another unforeseen agent intervenes.

Warm Springs Unit
Acreage 54,500

Survey Record	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.421	1.748	2.333	20.852	31.881	.775	58,010
Att. trees on unit	22,966	95,268	127,142	1,135,856	1,736,678	42,241	3,160,151
% change over prev. year	---	315	33.5	793.8	52.9	-97.6	---

Destruction was so great on this unit in 1931 and 1932 that it seems unlikely that the outbreak can build up to appreciable volume in the next few years, certainly not to an amount equaling the number killed in 1932.

East Side Unit
Acreage 86,200

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.428	.794	3.513	5.017	17.626	7.666	.064	35.108
Att. trees on unit	21,110	68,411	302,780	432,488	1,519,783	660,867	13,403	3,018,842
% change over prev. year	---	86	342	42.8	251.3	-56.5	-99.2	---

The decline in annual losses in 1932 indicates that the outbreak passed its peak the preceding year on this unit, and although the 1933 losses were extremely low, still we may expect comparatively light losses during the duration of the outbreak on this area.

Lower Wise River Unit
Acreage 59,000

Survey Record	1927	1928	1929	1930	1931	1932	1933	Total
Att. trees per strip acre	.058	.105	.479	1.164	3.916	15.134	2.264	23.120
Att. trees on unit	3,557	6,191	28,294	68,694	231,068	893,323	133,578	1,364,715
% change over prev. year	---	81	356	143.0	236.4	286.5	-85	---

Unless natural control factors again intervene, we may expect the infestation to increase on this area for a number of years, as there is still a large volume of mature timber to favor such a development.

GENERAL STATUS OF THE BEAVERHEAD INFESTATION

It has been stated in the introduction to this report that the main objective of these annual surveys has been to study the development of the mountain pine beetle infestation on the Beaverhead National Forest. The increase in the outbreak was abruptly arrested in 1932-33, but it is believed the general trend showing what would have happened, based on the preceding years, can be given with reasonable accuracy. By securing such an estimate we can better visualize what can normally be expected from a similar infestation, and also secure a more definite idea of the reduction caused by the agency in the winter of 1932-33.

In 1932 five units on the forest (Pintler, Battlefield, West Side, and East Side) showed a reduction in the number of attacked trees, indicating that the peak of losses was reached on them in 1931. This decrease would almost certainly have continued on these same units in 1933. Adjoining them were four others (Mussigbrod, Jackson, Bloody Dick, and Warm Springs) which had been subjected to comparable conditions of infestation and on which such heavy losses had occurred by 1932 that they too would probably have shown decreases in the amount of infestation in 1933. Units on which an increase was expected due to the short period the infestation has been serious on them and the plentiful supply of host material are the Rattlesnake, Grasshopper, Melrose, and the two Wise River areas. However, it is improbable that the increases on these five units in 1933 would have offset the losses on the other eight, and the total losses for the forest would probably have been less than in 1932. The actual number, of course, can not be accurately estimated, but it probably would have been in excess of ten million. The control agency reduced the number to about 870,000, and thus destroyed the great impetus this infestation had developed. The future trend of the outbreak is problematical, although it seems likely that the areas on which losses have been the lightest will show a gradual increase in infestation. Where a decrease was expected in 1933 it seems unlikely that losses will become very serious in the future. The outbreak would have to build up in a stand increasingly resistant to bark-beetle attacks.

It must be borne in mind that the parasite, predator, and secondary insect population may not have been reduced in the same degree as the bark beetles. We already have indications of such a condition with the large proportion of the 1933-attacked trees showing usually secondary bark beetles assuming a primary role. The future effect of these bark beetles, parasites, and predators can not be foreseen at present.

MOUNTAIN PINE BEETLE FLIGHT

The decided reduction in the bark-beetle population in 1933 seems to have prevented extended flights of beetles or else the number that did migrate to distant areas were so few as to cause no increases that could be identified as having their inception in invading insects from distant sources.

The Sheep Canyon Hills area showed a 91.6 percent reduction in infestation, which is almost as great as the main portion of the Beaverhead. The infestation on the three forks of Blacktail Creek and adjoining areas only indicated a 61.2 percent reduction. The reason for the latter discrepancy is not apparent, but it is suggested that possibly these areas were outside the area affected by the extreme cold; that the timbered portions were at higher elevations above the area of intense cold, or else the snow was so deep as to prevent high mortality as occurred on the main portion of the Beaverhead.

Tables IX and X give the data concerning these areas.

DATA CONCERNING ADMINISTRATION OF THE SURVEY

The area of the strips run on the Beaverhead National Forest in 1933 amounted to .51 of one percent of the total area of the forest covered by the survey, as compared with .45 for 1932, .87 for 1931, and .69 for 1930.

The average amount of strip per man-day increased in 1933 due in general, it is believed, to the lighter infestation necessitating the securing and entrance of less data.

Data concerning the administration of the survey are given in Table XI.

TABLE IX

Status of the Mountain Pine Beetle Infestation on Blacktail Creek Drainage from 1930 to 1933

Area	Acreage of area	No. of trees treated in 1931 (1)	Probable No. of trees left in 1931 (1)	Trees attacked in 1931	Trees attacked in 1932	Trees attacked in 1933
Sheep Canyon	23,680	3,045	500	23,183	151,000	14,858
E. Fk. Blacktail	12,800	641	200 (3)	2,050	8,232 (6)	3,077
Mid. Fk. Blacktail	3,520	196	---	350	---	1,191
West Fk. Blacktail	19,840	971	250 (2)	3,200	11,085 (5)	1,782
Clover, Wolverine, West & Middle Creeks	5,140	---	---	1,375 (4)	---	131
Little Basin Cr.	4,480	---	---	---	---	1,323
Totals	69,460	4,853	950	30,158	170,317	22,362 (7)

(1) 1930 attack. (2) Includes one group of 45 trees. (3) Includes large untreated area. (4) Included in West and East Forks in 1930. (5) West Fork and Middle Fork data. (6) Clover, Wolverine, West & Middle Creeks data included. (7) Total for all but Sheep Canyon, 7,504.

TABLE X
Data of the 1933 Survey of Blacktail Creek Drainage

Area	Acres of strip run	Attacked trees on strip			Attacked trees per acre	% of total area surveyed
		LP	WbP	Total		
Sheep Canyon	460.6	278	11	289	.627	1.95
East Fork /	249.6	32	28	60	.240	1.95
Middle Fork	93.9	20	16	36	.383	2.67
West Fork	378.6	23	11	34	.090	1.95
Clover, Wolverine, West & Middle Creeks	78.3	1	1	2	.025	1.52
Little Basin Cr.	81.3	16	8	24	.295	1.81
Totals	1,342.3	370	75	445	.331	1.93

TABLE XI
SUMMARY AND ANALYSIS OF COSTS OF BEAVERHEAD NATIONAL FOREST SURVEY - 1933

	Man-Days on Project				
Items	Unit Strip(1)	Check Strip	Office	Ineff. (3)	Total
Man-Days spent on survey	96	17	29	53	195
Miles of sample strip					903.9
Miles of strip per man-day	9.41				
No. of sample strip acres	7,231.42 (2)				
No. of sample strip acres per man-day	77.5				
Acres covered by survey					1,415,340
Acres covered per man-day	14,743				

Total Cost of Survey

Labor	$ 723.84	$191.72	$ 915.56
Transportation	63.14		63.14
Subsistence	339.40		339.40
	$1,126.38	$191.72	$1,318.10

Cost of Survey Distributed

Cost per man-day	$6.76
" " mile of strip	1.46
" " sample acre	.182
" " acre of region surveyed	.00093
Percent of total area actually covered by survey	.51

(1) Consists only of the strip run on the units to determine the amount of infestation.

(2) Includes the three strips repeatedly examined to determine the amount of attack for different periods.

(3) Analysis of ineffective time.

Sundays	24
Rain and snow	10
Travel	15 (11 to and from project (4 on project
Compensatory time	4

SUMMARY

The outstanding findings of the 1933 survey were as follows:

1. A decrease in the number of trees attacked by the mountain pine beetle from 17,586,171 to 869,647, due chiefly, it is believed, to severe cold during the winter of 1932-33.

2. Evidence that mortality from the control agency was greatest on areas which had suffered the heaviest losses from the outbreak.

3. Indications that secondary insects did not suffer as high a mortality from the control agency as the mountain pine beetle.

4. No indication that any flights of bark beetles from other forests or between units within the forest had occurred.

5. Bark beetles usually secondary in habits assumed a primary role and were the major cause of death of most of the trees killed in 1933.

6. Evidence that secondary insects killed the greatest number of trees on units which had suffered most severely from the outbreak.

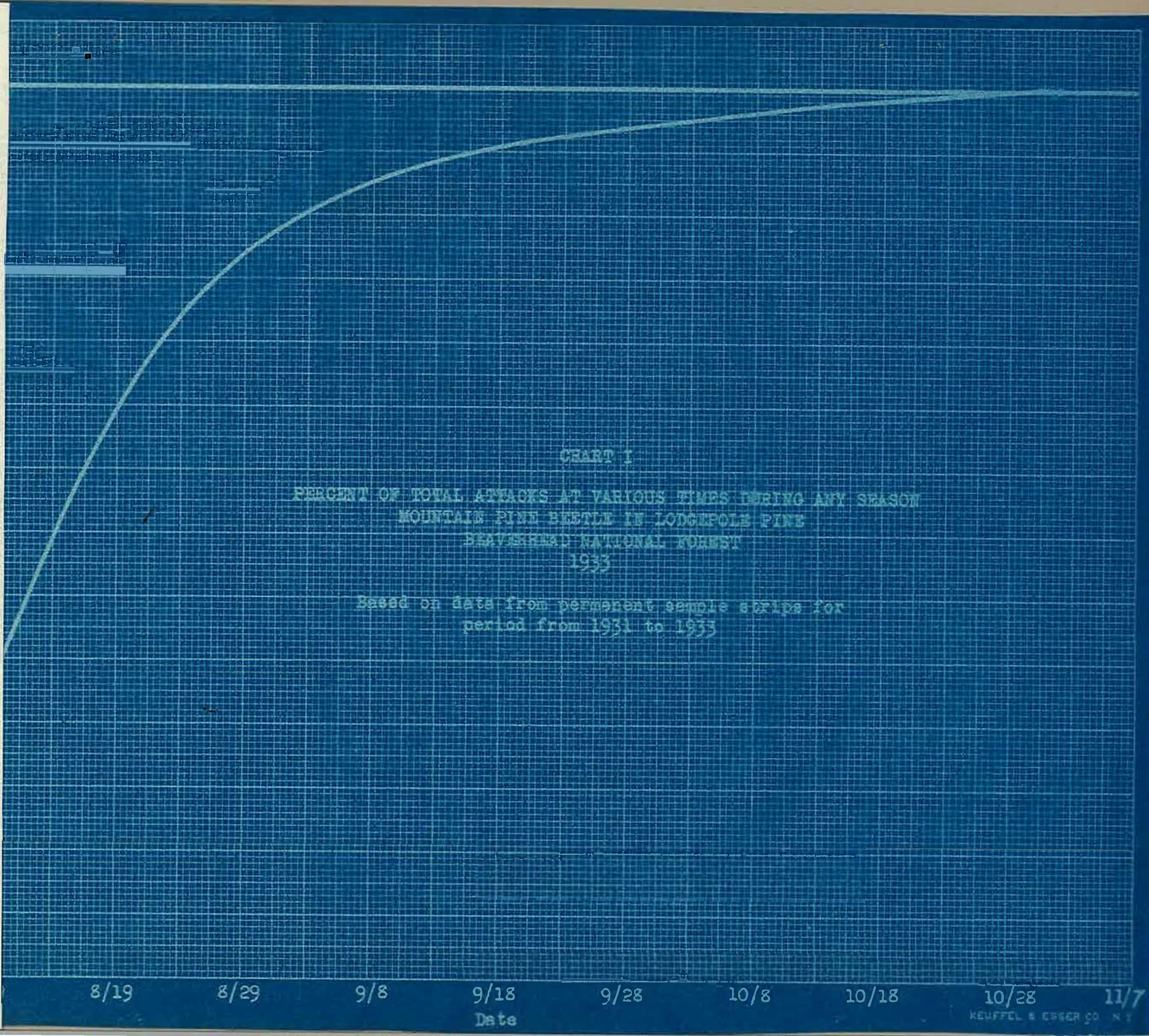

CHART I

PERCENT OF TOTAL ATTACKS AT VARIOUS TIMES DURING ANY SEASON
MOUNTAIN PINE BEETLE IN LODGEPOLE PINE
BEAVERHEAD NATIONAL FOREST
1933

Based on data from permanent sample strips for
period from 1931 to 1933